1 **(a)** On the axes of Fig. 7.1, sketch a stress against strain graph for a typical ductile material.

Fig. 7.1

[2]

(b) Circle from the list below a material that is ductile.

jelly c amic gl **[1]**

(c) Define *ultimate tensile strength* of a material.

....

.... **[1]**

(d) State *Hooke's law*.

....

.... **[1]**

(e) Fig. 7.2 shows a mechanism for firing a table tennis ball vertically into the air.

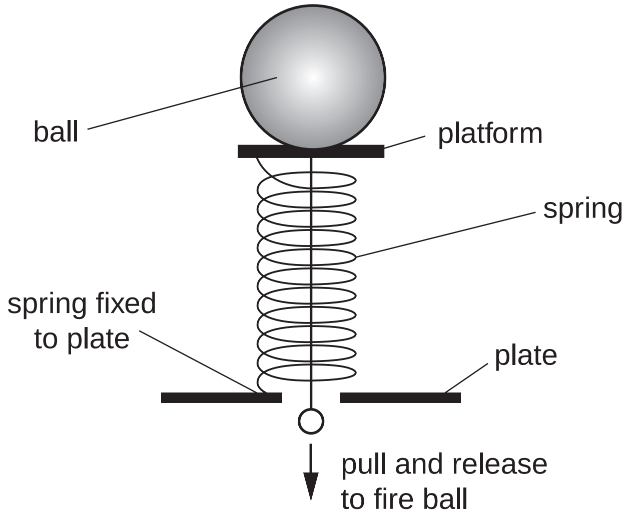

Fig. 7.2

The spring has a force constant of $75\,N\,m^{-1}$. The ball is placed on the platform at the top of the spring.

(i) The spring is compressed by 0.085 m by pulling the platform. Calculate the force exerted by the compressed spring on the ball **immediately** after the spring is released. Assume both the spring and the platform have negligible mass.

force = ... N **[2]**

(ii) The mass of the ball is 2.5×10^{-3} kg. Calculate the initial acceleration of the ball.

acceleration = ... $m\,s^{-2}$ **[1]**

(iii) Calculate the maximum height that could be gained by the ball. Assume all the elastic potential energy of the spring is converted into gravitational potential energy of the ball.

height = ... m **[3]**

[Total: 11]

2 A sample of wire is tested in the laboratory. Fig. 8.1 shows the force, F against extension, x graph for this wire.

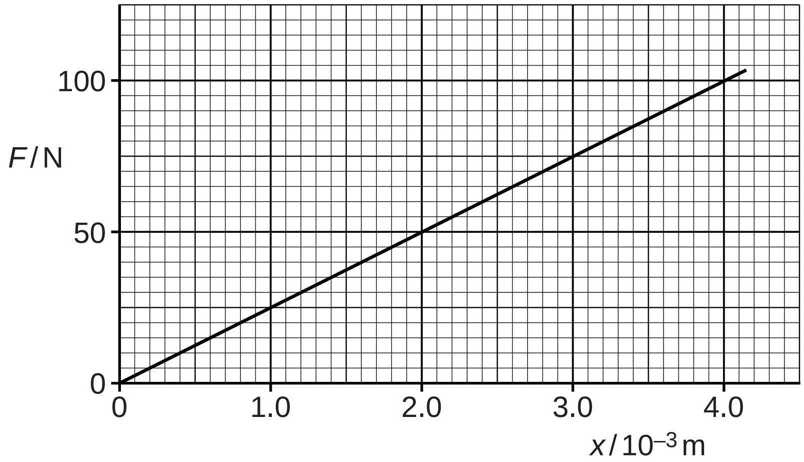

Fig. 8.1

(a) Explain how the graph shows that the wire obeys Hooke's law.

In your answer, you should use appropriate technical terms, spelled correctly.

....

.... **[1]**

(b) State what the gradient of the graph represents.

.... **[1]**

(c) The initial length of the wire is 1.60 m. The radius of the wire is 2.8×10^{-4} m. Use the graph and this information to determine the Young modulus of the material of the wire.

Young modulus = ... Pa **[3]**

(d) The test is repeated for another wire made from the same material, having the same length but **half** the diameter. Explain how the force against extension graph for this wire will differ from the graph of Fig. 8.1.

....

....

....

....

.... **[2]**

(e) It is very dangerous if the wire under stress suddenly breaks. The elastic potential energy of the strained wire is converted into kinetic energy. Show that the 'whiplash' speed v of the wire is directly proportional to the extension x of the wire.

....

....

.... **[2]**

[Total: 9]

3 **(a)** State *Hooke's law*.

....

.... **[1]**

(b) Fig. 6.1 shows a force against extension graph for a spring.

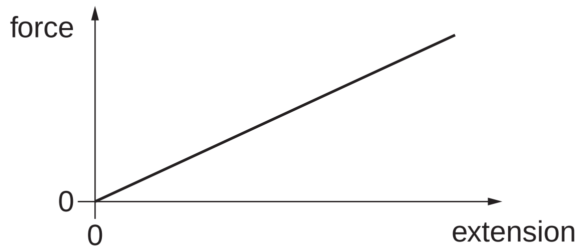

Fig. 6.1

Describe how such a force against extension graph can be used to determine

(i) the *force constant* of the spring

In your answer, you should use appropriate technical terms, spelled correctly.

....

.... **[1]**

(ii) the *work done* on the spring.

....

.... **[1]**

(c) Two identical springs are connected end-to-end (series). The force constant of each spring is k. The free ends of the springs are pulled apart as shown in Fig. 6.2.

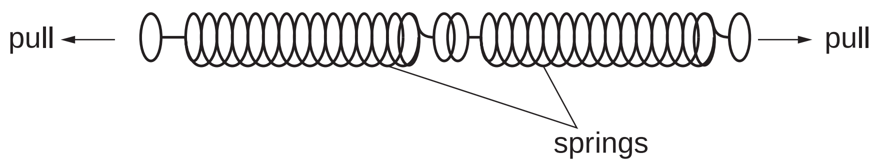

Fig. 6.2

Explain why the force constant of this combination of two springs in series is $\frac{k}{2}$.

....

....

.... **[2]**

(d) **(i)** Define the *Young modulus* of a material and state the condition when it applies.

....

....

.... **[2]**

(ii) A guitar string has length 0.70 m and cross-sectional area 0.20 mm^2. A constant tension of 4.2 N is applied to the string causing a strain of 0.015. Calculate

1 the stress in the string

stress = ... Pa **[2]**

2 the Young modulus of the material of the string

Young modulus = ... Pa **[2]**

3 the elastic potential energy (stored energy) in the string.

energy = ... J **[3]**

[Total: 14]

4 (a) Fig. 7.1 shows stress against strain graphs for materials **X**, **Y** and **Z** up to their breaking points.

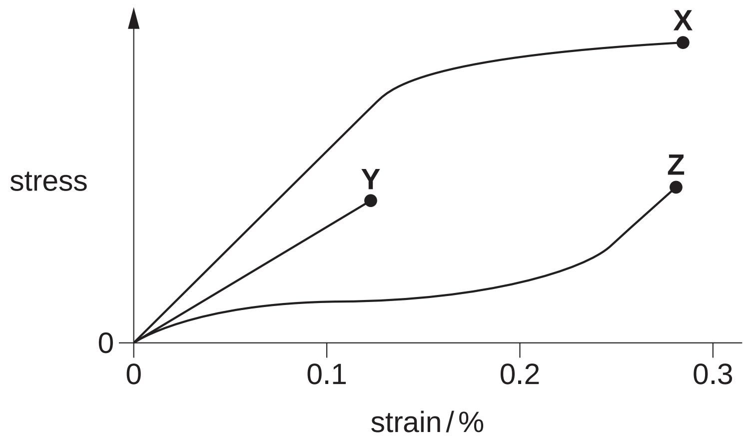

Fig. 7.1

(i) State which of these three materials is brittle.

.... **[1]**

(ii) State one similarity between the properties of materials **X** and **Y** for strains less than 0.05%.

....

.... **[1]**

(iii) State and explain which material has the greatest value for the Young modulus.

....

....

.... **[2]**

(b) Engineers are testing a new material to be used as support cables for a bridge. In a laboratory test, the breaking force for a sample of the material of diameter 0.50 mm is 240 N. Estimate the breaking force for a cable of diameter 15 mm made from the same material.

breaking force = ... N **[2]**

[Total: 6]

5 The force against length graph for a spring is shown in Fig. 6.1.

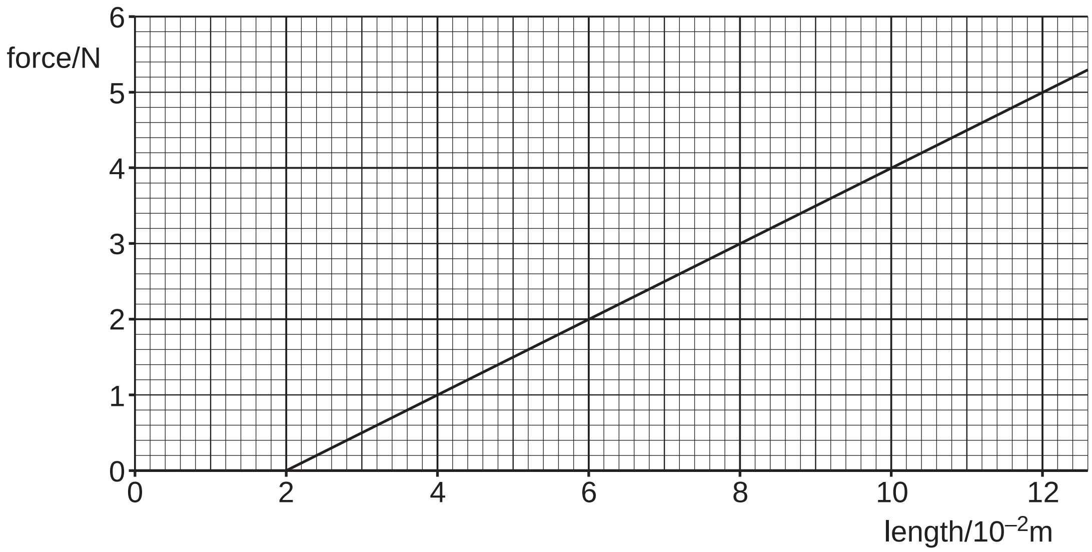

Fig. 6.1

(a) Explain why the graph does not pass through the origin.

....

.... **[1]**

(b) State what feature of the graph shows that the spring obeys Hooke's law.

....

.... **[1]**

(c) The gradient of the graph is equal to the force constant k of the spring. Determine the force constant of the spring.

force constant = ... N m^{-1} **[2]**

(d) Calculate the work done on the spring when its length is increased from 2.0×10^{-2} m to 8.0×10^{-2} m.

work done = ... J **[2]**

(e) One end of the spring is fixed and a mass is hung vertically from the other end. The mass is pulled down and then released. The mass oscillates up and down. Fig. 6.2 shows the displacement *s* against time *t* graph for the mass.

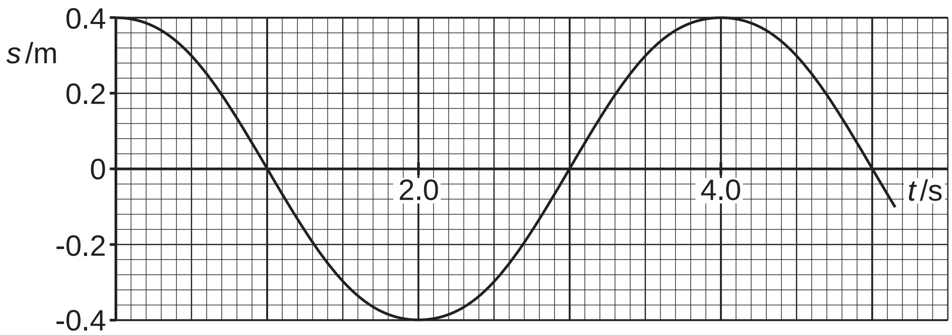

Fig. 6.2

Explain how you can use Fig. 6.2 to determine the **maximum** speed of the mass. You are not expected to do the calculations.

....

....

....

.... **[2]**

[Total: 8]